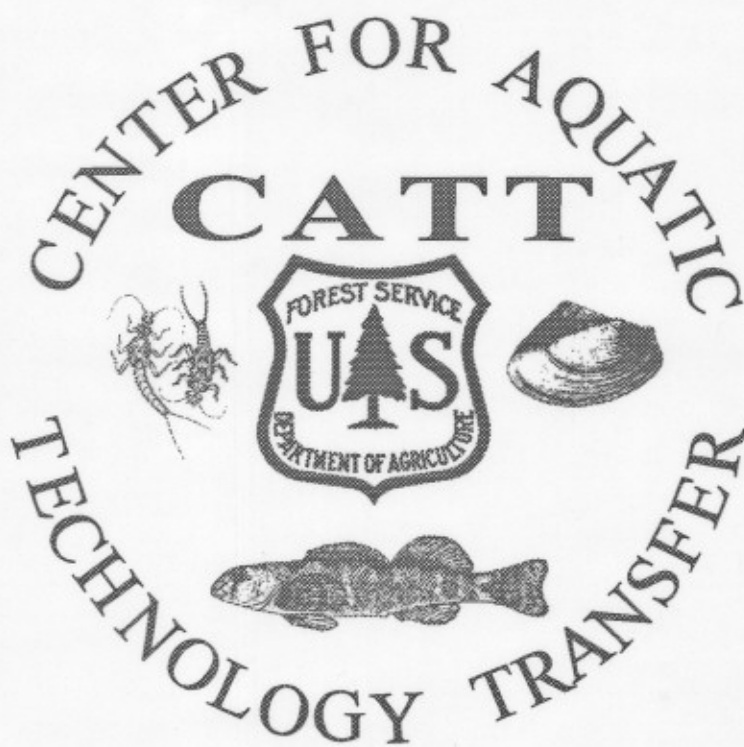


**Stream Habitat Inventory, with Emphasis on Large Woody Debris, of the
Upper Overflow Creek Watershed, Nantahala National Forest**



United States Department of Agriculture Forest Service
Center for Aquatic Technology Transfer
Department of Fisheries and Wildlife Sciences
Virginia Tech, Blacksburg, VA 24061-0321

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Introduction

We modified Basinwide Visual Estimation Techniques (BVET [Dolloff et. al 1993]) to measure specific stream habitat parameters related to a stream enhancement project on the Highlands Ranger District, Nantahala National Forest. In July 1997, we sampled sections of East Fork Overflow Creek and West Fork Overflow Creek to estimate woody debris loading, amount of pool and riffle area, substrate composition, silt embeddedness, stream depth, and the width of the riparian area. We also mapped the distribution and position (across, left, middle, and right) of woody debris within the channel in both East Fork Overflow Creek and West Fork Overflow Creek.

The purpose of this report is to describe current stream habitat to help Forest Service managers make decisions about stream habitat improvement projects in the Overflow Creek Watershed.

Methods

Two-stage visual estimation techniques were used to quantify stream habitat in a 2.6 kilometer section of East Fork Overflow Creek beginning on Overflow Creek 0.16 kilometers downstream from the confluence with East Fork Overflow Creek and ending approximately 0.8 kilometers above Rt. 79 culvert (Figure 1). The West Fork Overflow Creek section started at the East Fork Overflow confluence and ended 0.65 kilometers upstream at the confluence with Abes Creek (Figure 1). During the first stage, all habitat units were classified and the surface area and depth were estimated. Sampling strata were based on naturally occurring habitat units including pools (an area in the

stream with low water velocity, streambed gradient near zero, and a smooth water surface), glides (an area in the stream that is morphologically similar to pools but with swift flow through most of the unit), runs (an area in the stream with relatively steep gradient, with rapid, non-turbulent flow), and riffles (an area in the stream with relatively steep gradient, shallow water, relatively high velocity, and turbulent surface).

Habitat in both sections was classified and inventoried by a two-person crew. One crew member identified each habitat unit by type, estimated surface area, classified the dominant (covering the major percentage of the wetted channel) and subdominant (covering the second highest percentage of the wetted channel) substrate, silt embeddedness was assessed by visually estimating the proportion of the substrata and interstitial spaces covered with fine silt particles embeddedness, and estimated the average and maximum depth of each habitat unit. Average depth of each habitat unit was estimated by taking depth measurements at various places across the channel profile with a graduated staff marked in 0.1 m increments. The length (0.1 m) of each habitat unit was measured with a hip chain.

Another crew member classified and inventoried large woody debris (LWD), associated with each habitat unit (within the stream channel) and recorded the data on a field data logger. LWD was divided into four classes: 1) less than 15-ft long, less than 14-in diameter, 2) less than 15-ft long, greater than 14-in diameter, 3) greater than 15-ft long, less than 14-in diameter, and 4) greater than 15-ft long, greater than 14-in diameter. LWD less than 4-ft long and less than 4-in diameter were omitted from the survey. Also position (across channel, left bank, middle of channel, and right bank)

of large woody debris within the channel for each size class in each unit was inventoried.

The first unit of each habitat type selected for intensive sampling (accurate measurement of surface area - second stage sampling) was determined randomly. Additional units were selected systematically (one unit out of 5 for each habitat type). The width of these systematically selected habitat units was measured with a 30-m measuring tape at intervals ranging from about 1 to 5 m. Interval size was determined by the length and the morphology of the unit (e.g., intervals of measured widths increased with increasing unit length).

The relationship between the estimated surface area and the measured surface area typically is strongly and positively correlated when the estimates are made by experienced personnel. Visual estimates were therefore multiplied by a calibration ratio (Hankin and Reeves 1988) to correct for observer bias. The calibration ratio (\hat{Q}), the estimated true total area (\hat{M}), and the variance of the area estimator $\hat{V}(\hat{M})$ were calculated separately for each habitat type and each stream.

In each of the systematically selected riffles we also measured the stream channel width (m) at bankfull and riparian width (m) as described by Harrelson et. al 1994. We used this information to describe the channel and flood plain associated with the Upper Overflow Creek Watershed.

BVET calculations were computed using a Statistical Analysis Systems (SAS) program developed by Dr. Patricia Flebbe (100 Cheatham Hall, VA Tech, Blacksburg, VA 24061-0321). Data were summarized using a spreadsheet, graphics program, and

statistical program.

Results and Discussion

East Fork Overflow Creek

We identified 78 pools, 35 glides, 30 runs, and 91 riffles in the East Fork Overflow Creek study section. Visual estimates of habitat areas were paired with measured habitat area for 14 (12.4%) pools-glides and 14 (11.6%) runs-riffles. We estimated that the East Fork Overflow Creek section contained 57.6% pool habitat ($9,914 \text{ m}^2 \pm 1,377.4$) of and 42.4% riffle habitat ($7,304 \text{ m}^2 \pm 882.8$) (Figure 2). Total area was estimated for each habitat type using correction factors (\bar{Q}) that ranged from 0.99 to 1.01.

We estimated the average riparian width in the East Fork Overflow Creek section to be 47.5 m. The width of the 100 year riparian area, however, was highly variable (Figure 3).

The mean pool-riffle crest depth in the East Fork Overflow Creek study section was 16 cm (Figure 4). Mean maximum depth was 62 cm for pools-glides, 33 cm for runs-riffles; and the mean average depth was 46 cm for pools-glides, 20 cm for runs-riffles. Both maximum and average depth were variable within and among habitat types (Figures 5 and 6).

We identified bedrock and cobble as the most common (modal) dominant and

subdominant substratum, respectively, in the East Fork Overflow Creek study section with sand also prevalent throughout the section. The dominant and subdominant substrata, however, varied between habitat types (Figures 7 and 8). In general, the substrate embeddedness in the East Fork Overflow Creek study section was low; silt covered less than 25% of the substrata in most cases (Figure 9).

East Fork Overflow Creek contained about 132 pieces of LWD per kilometer. This section contained more than 88 pieces per kilometer of the larger size classes which are the most stable and most capable of forming instream habitat and providing cover for fishes (Figure 10). LWD pieces in the smaller two size classes were found in all positions with left and right bank positions being the most common (Figure 11). This was similar for the two larger size classes but with numerous pieces in the across position, which is expected because LWD length is over 15 ft. for those two size classes (Figure 12).

West Fork Overflow Creek

We identified 15 pools, 12 glides, 7 runs, and 16 riffles in the West Fork Overflow Creek study section. Visual estimates of habitat areas were paired with measured habitat area for 5 (19%) pools-glides and 4 (17%) runs-riffles. We estimated that the West Fork Overflow Creek section contained 60.2% pool habitat ($2,185.3 \text{ m}^2 \pm 628.6$) and 39.8% riffle habitat ($1,442.4 \text{ m}^2 \pm 293.7$) (Figure 13). Total area was estimated for each habitat type using correction factors (\hat{Q}) that ranged from 0.95 to

1.06.

We estimated the average riparian width in the West Fork Overflow Creek section to be 19.8 m. The width of the 100 year riparian area, however, was highly variable (Figure 14).

The mean pool-riffle crest depth in the West Fork Overflow Creek study section was 21 cm (Figure 4). Mean maximum depth was 79 cm for pools-glides, 53 cm for runs-riffles; and the mean average depth was 45 cm for pools-glides, 25 cm for runs-riffles. Both maximum and average depth were variable within and among habitat types (Figures 15 and 16).

We identified sand as the most common (modal) dominant and subdominant substratum in the West Fork Overflow Creek study section with bedrock also prevalent throughout the section. The dominant and subdominant substrata, however, varied between habitat types (Figures 17 and 18). In general, the substrate embeddedness in the West Fork Overflow Creek study section was low; silt covered less than 25% of the substrata in most cases (Figure 19).

West Fork Overflow Creek contained about 73 pieces of LWD per kilometer. This section contained more than 48 pieces per kilometer of the larger size classes which are the most stable and most capable of forming instream habitat and providing cover for fishes (Figures 20). LWD pieces in the smaller two size classes were found mostly in the right and left bank positions (Figure 21). This was similar for the two larger size classes but with numerous pieces in the across position, which is expected because LWD length is over 15 ft. for those two size classes (Figure 22).

Conclusions

LWD debris forms pools and provides complex cover for fish and macro invertebrates (Dolloff 1994). The size and placement of LWD in addition to stream channel size, constriction, and gradient influence the size, shape, depth, and complexity of the pools they form (Sullivan et al. 1987). Pools with greater depth provide benefits to salmonids not provided by shallower pools. One such benefit is the ability of deep pools to allow more conspecifics to coexist (Frazer 1969; Allee 1982). As we mentioned before, because it is more stable and most capable, LWD of the larger size classes is better suited as use for habitat enhancement. Managers can use the distribution and position of the larger LWD size classes in both East Fork and West Fork of Overflow Creek (Figures 10, 11, 12, 20, 21, and 22) as a guide to identify locations where LWD is limited and place LWD pieces where needed. Our survey demonstrated that the larger size classes are found throughout both sections, and numbers are comparable to other streams in the Southern Appalachians (Dolloff et al. 1994; Flebbe and Dolloff 1995), but there are areas lacking LWD. Even though protocols for optimal placement of LWD are lacking we believe that LWD is needed between 500 and 1000 meters and between 1700 and 2300 meters of the East Fork Overflow Creek section. West Fork Overflow Creek LWD additions should be concentrated from 100 - 150 meters, 200 - 300 meters, and 400 - 550 meters.

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Table 1. Substrate classification criteria.

SUBSTRATE CLASSES		
<u>Rank</u>	<u>Size (inches)</u>	<u>Common</u> <u>name</u>
1		organic debris
2		clay
3		silt
4	silt- 0.08	sand
5	0.08 - 0.4	small gravel
6	0.4 - 4.0	large gravel
7	0.4 - 12.0	cobble
8	> 12.0	boulder
9		bedrock

Table 2. Substrata embeddedness: percentage of the substrata and interstitial spaces covered with fine silt and clay particles.

Embeddedness Rating	
<u>Rank</u>	<u>Percent coverage</u>
1	0 - 5
2	5 -25
3	25 - 50
4	50 -75
5	75 - 100

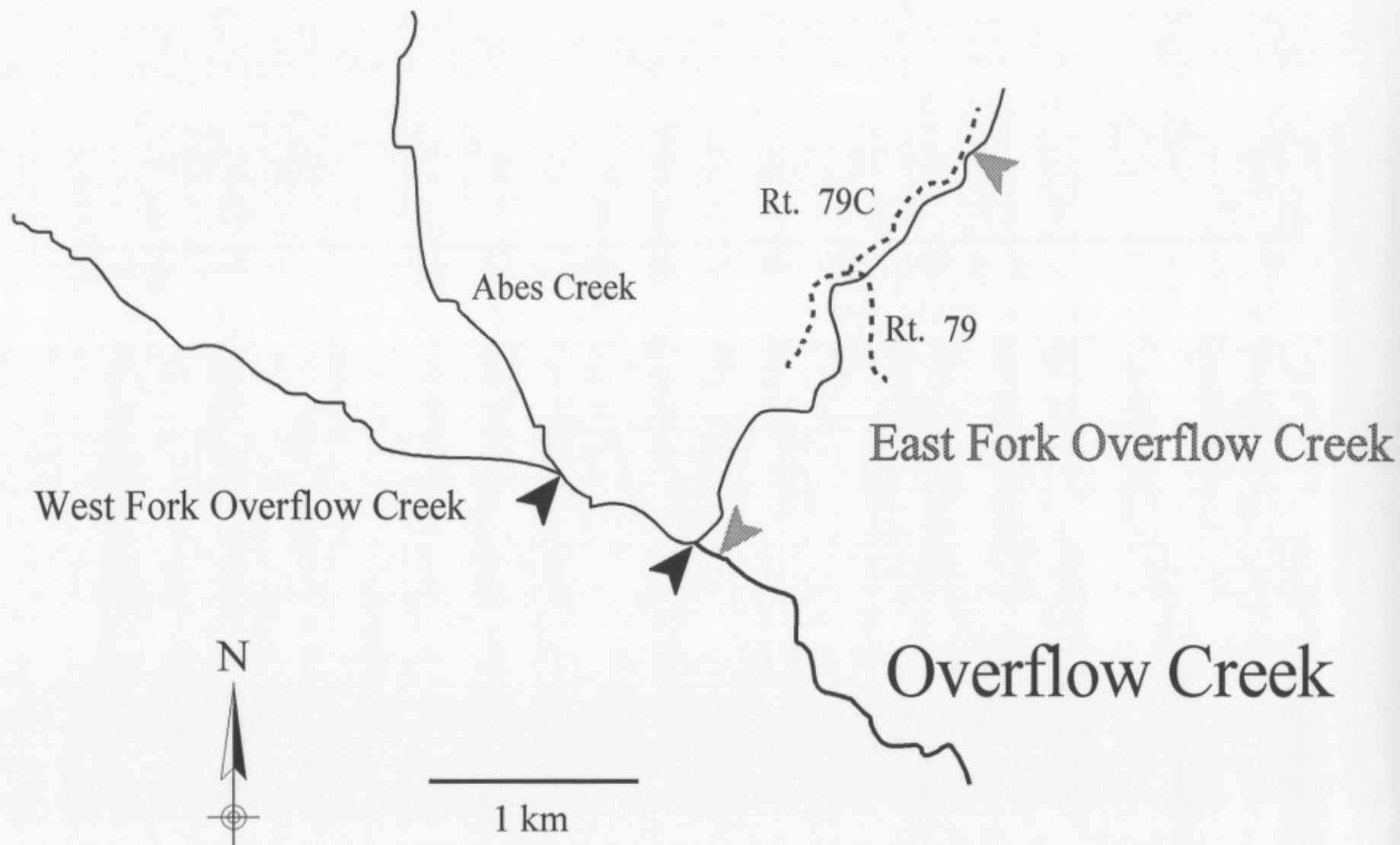


Figure 1. Map showing the Upper Overflow Creek Watershed. Arrows show starting and ending points of each section. East Fork Overflow Creek is shown in gray and West Fork Overflow Creek is shown in black.

Riparian Width

Stream: East Fork Overflow Creek

Number of measurements: 9

Mean width: 47.5 Std Dev: 37.6

Max: 105.0 Min: 14.4

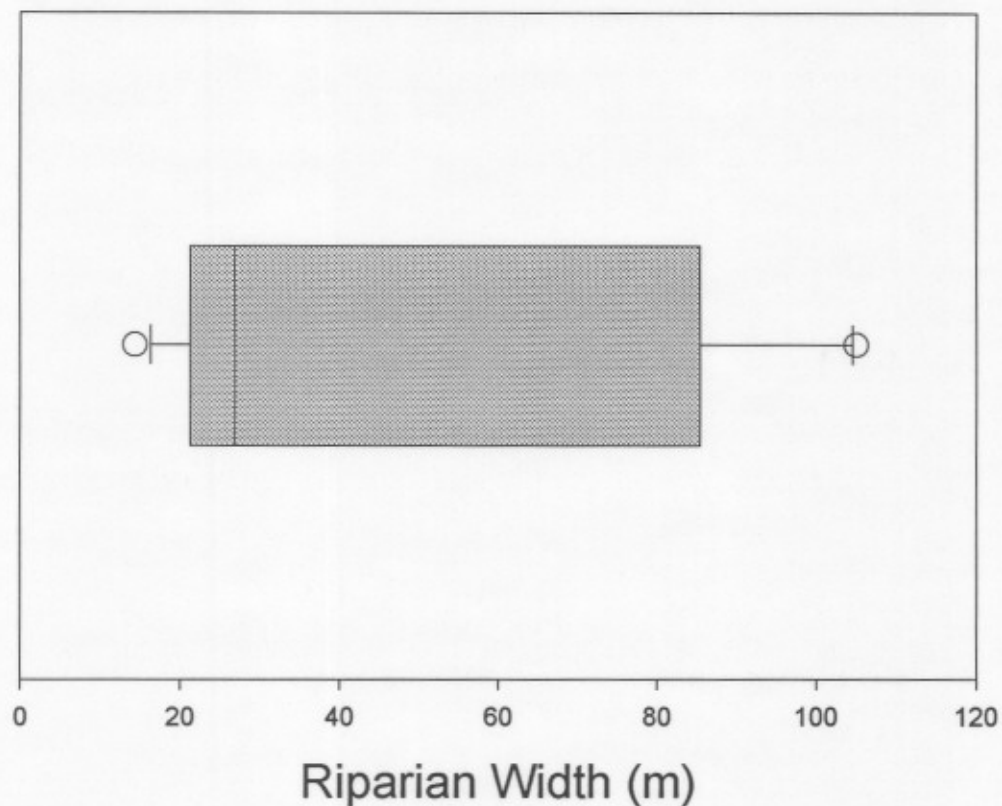


Figure 3. Box plots for riparian width in habitat-units of the East Fork Overflow Creek section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

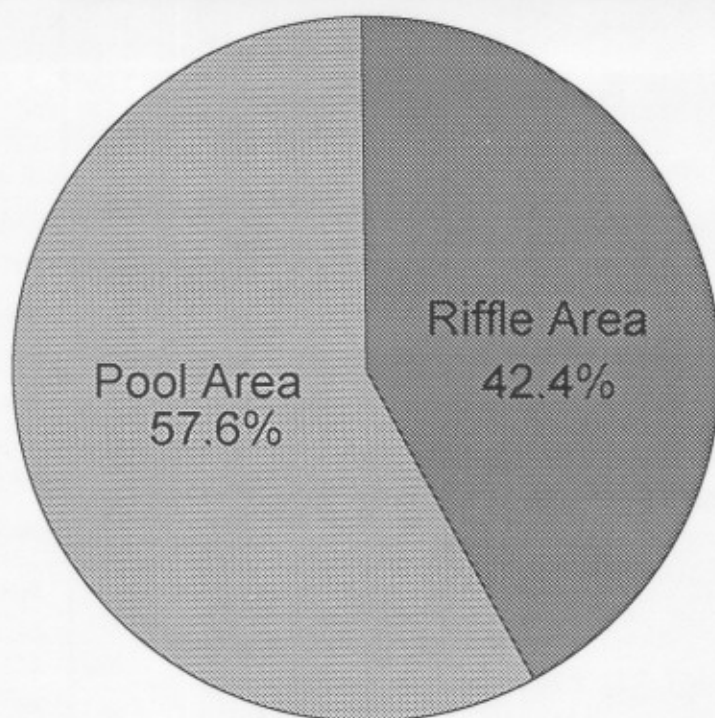


Figure 2. Pool:Riffle ratio for East Fork Overflow Creek.

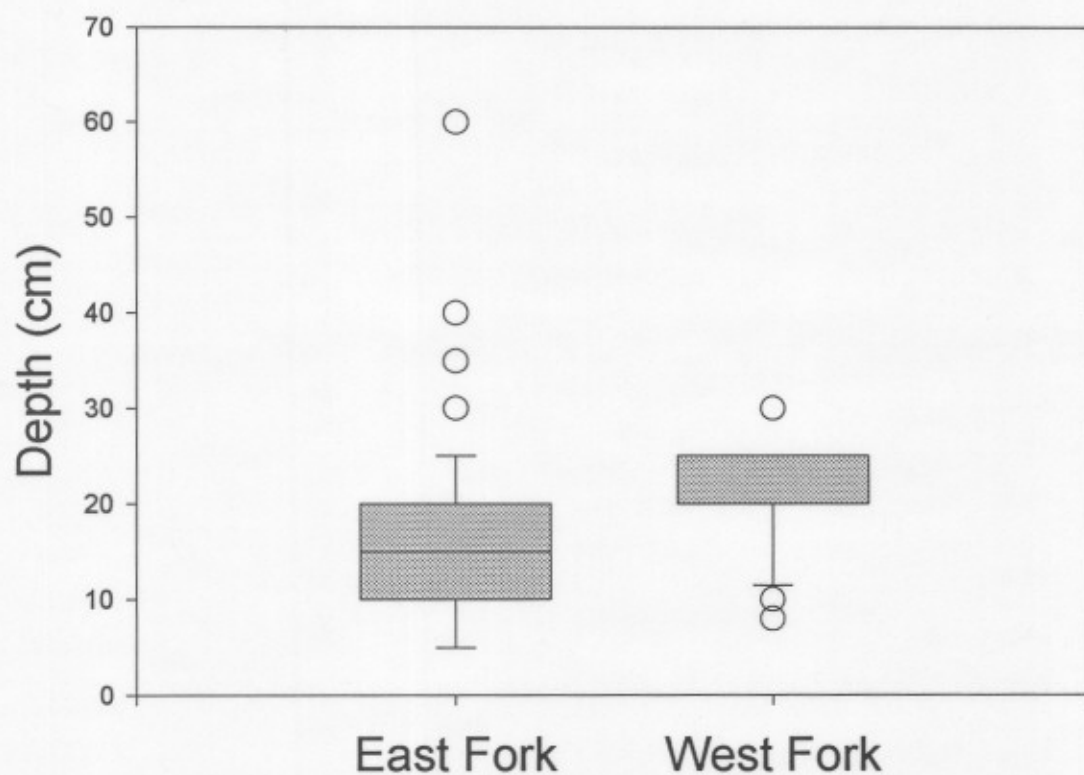


Figure 4. Box plots for pool-riffle crest depth in habitat-units by stream section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

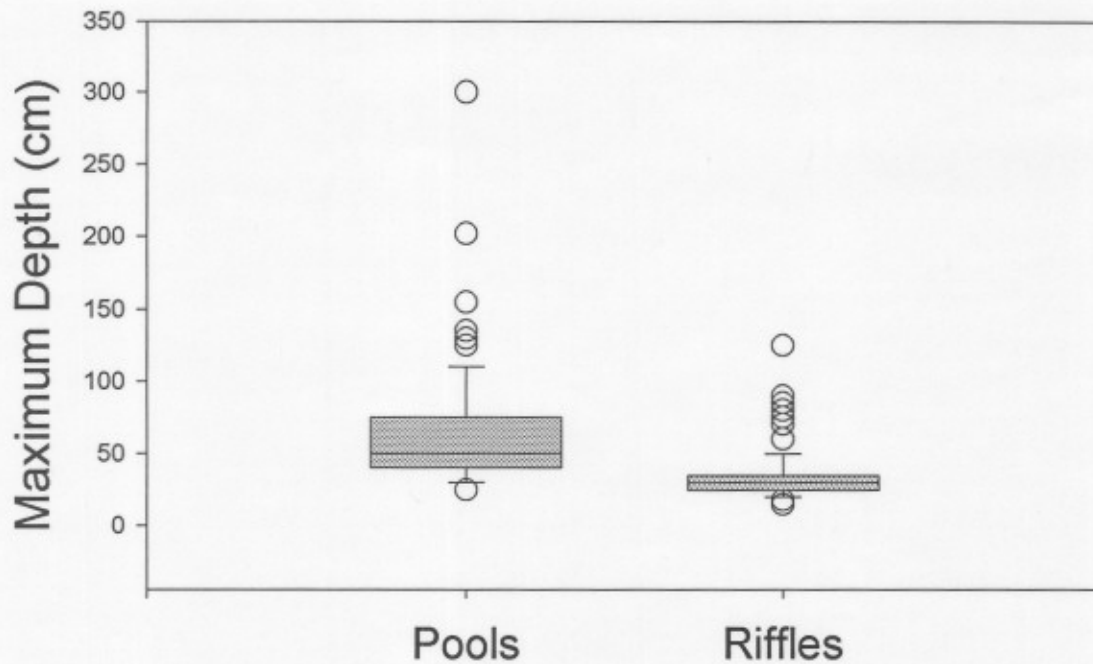


Figure 5. Box plots for habitat-unit maximum depth in the East Fork Overflow Creek section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

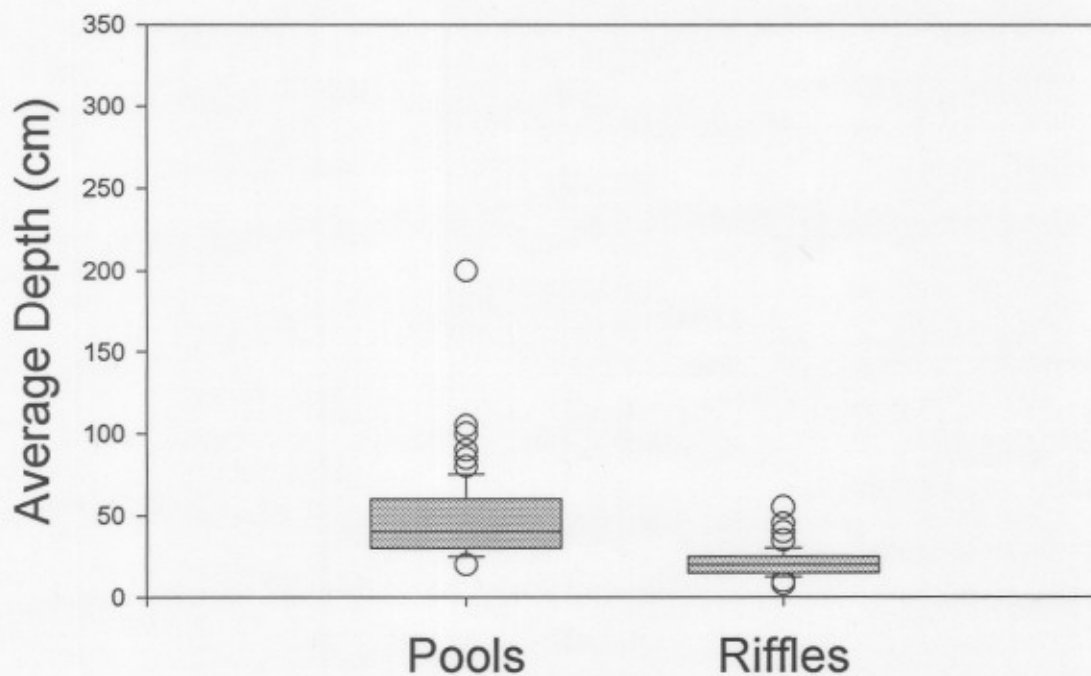


Figure 6. Box plots for habitat-unit average depth in the East Fork Overflow Creek section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

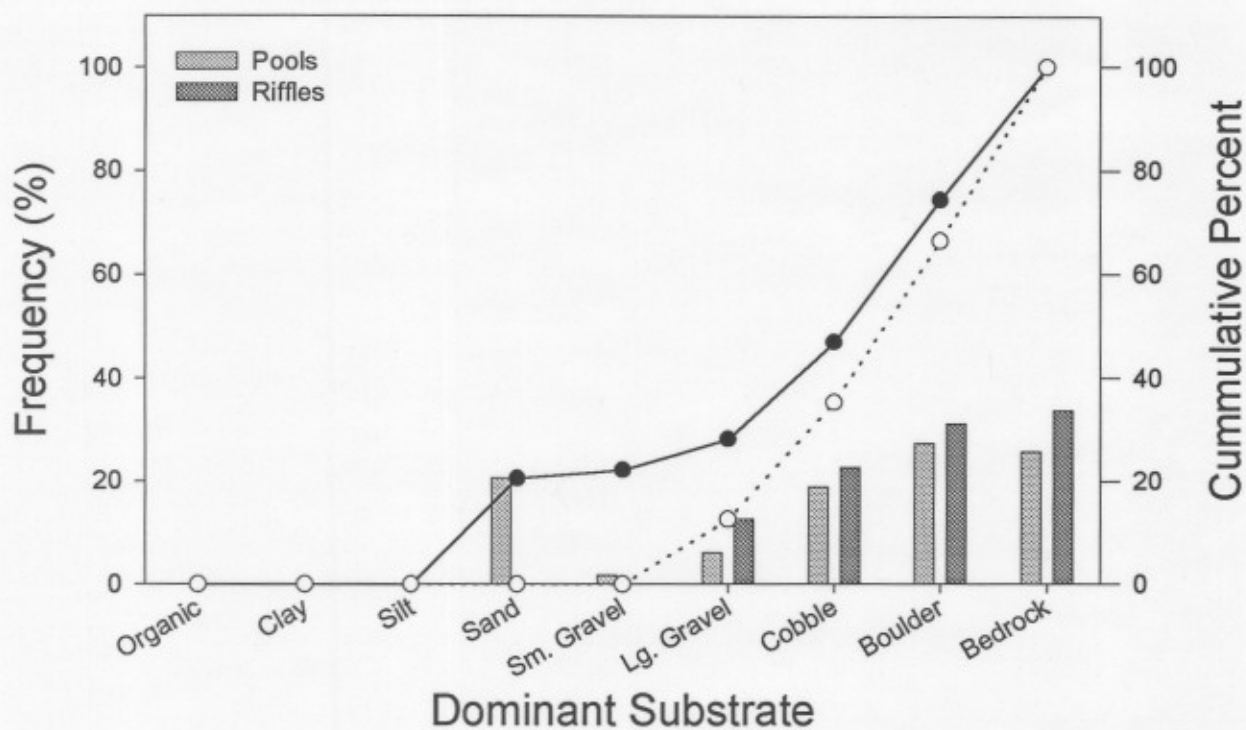


Figure 7. Frequency (percent) of dominant substrate occurrence by habitat type in East Fork Overflow Creek. Solid dots represent cumulative percent of pools and open dots represent cumulative percent of riffles.

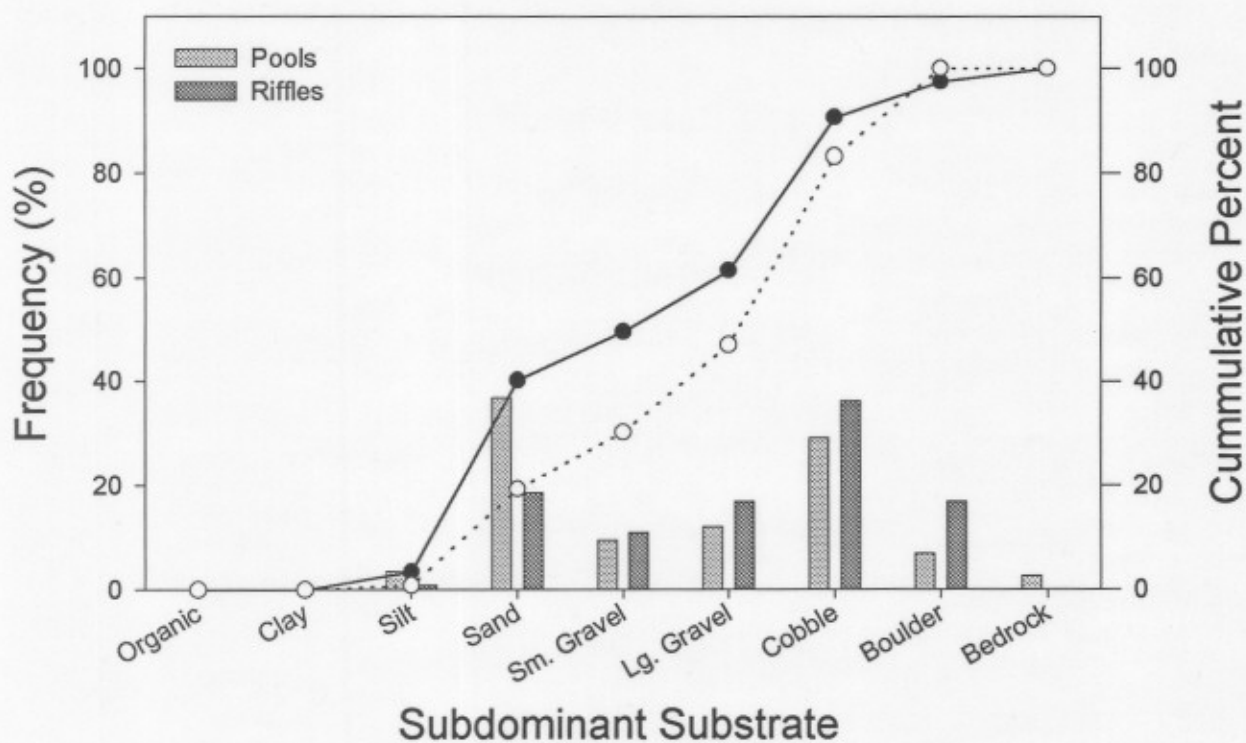


Figure 8. Frequency (percent) of subdominant substrate occurrence by habitat type in East Fork Overflow Creek. Solid dots represent cumulative percent of pools and open dots represent cumulative percent of riffles.

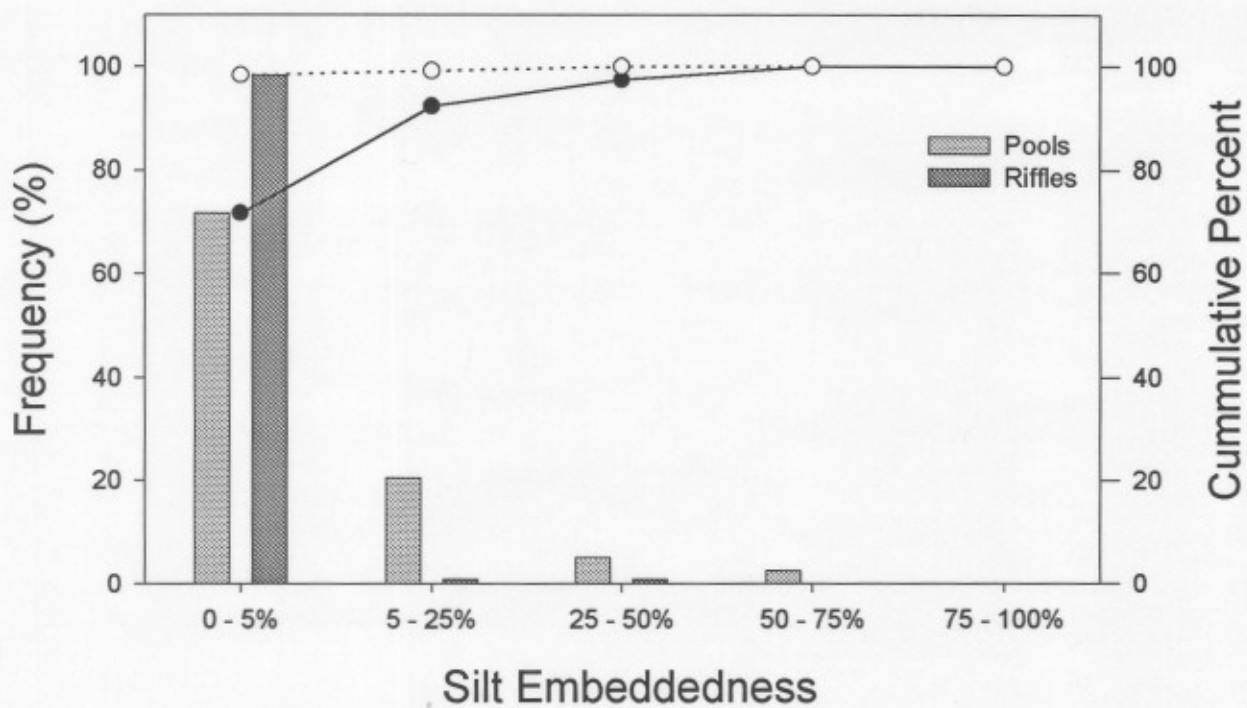


Figure 9. Frequency (percent) of pools and riffles in East Fork Overflow Creek best described by one of five classes of embeddedness. Solid dots represent cumulative percent of pools and open dots represent cumulative percent of riffles.

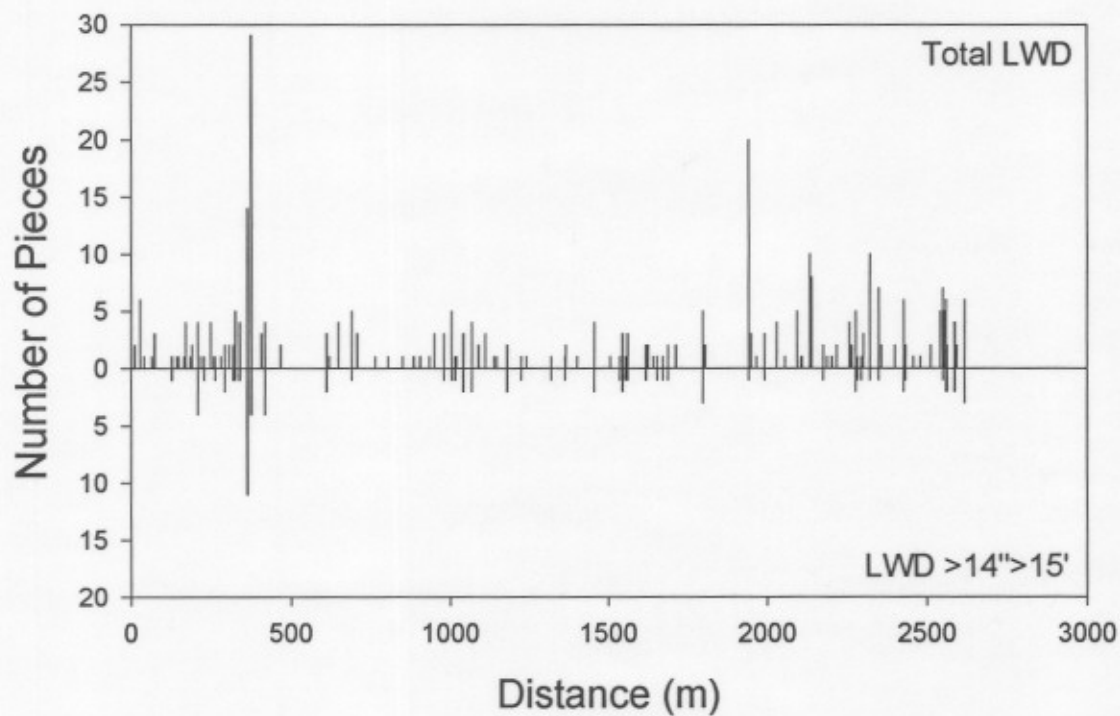


Figure 10. Distribution and total abundance of large woody debris in East Fork Overflow Creek.

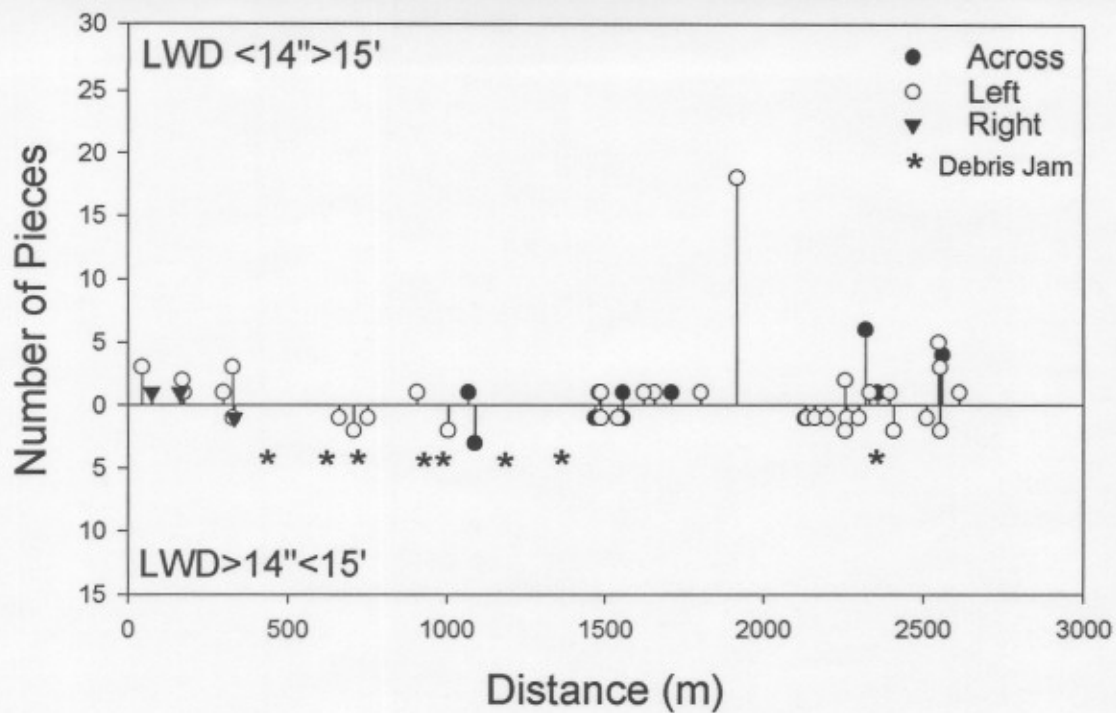


Figure 11. Distribution and position for the two smaller size classes of large woody debris in the East Fork Overflow Creek section. Asterisks denote debris jams.

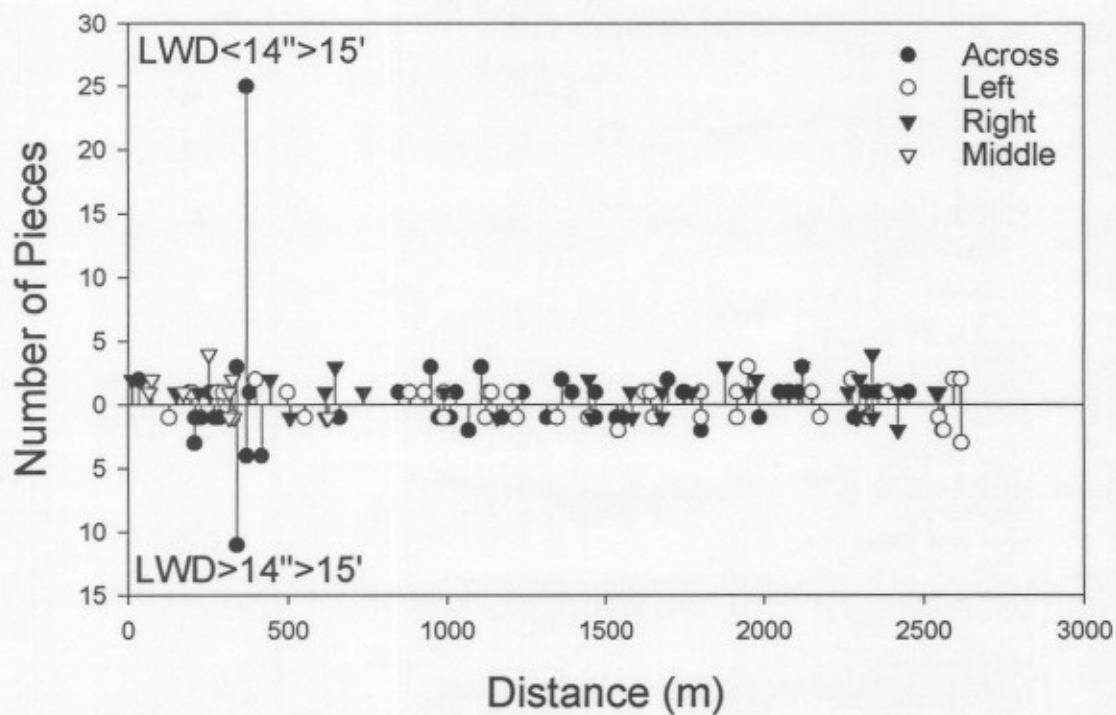
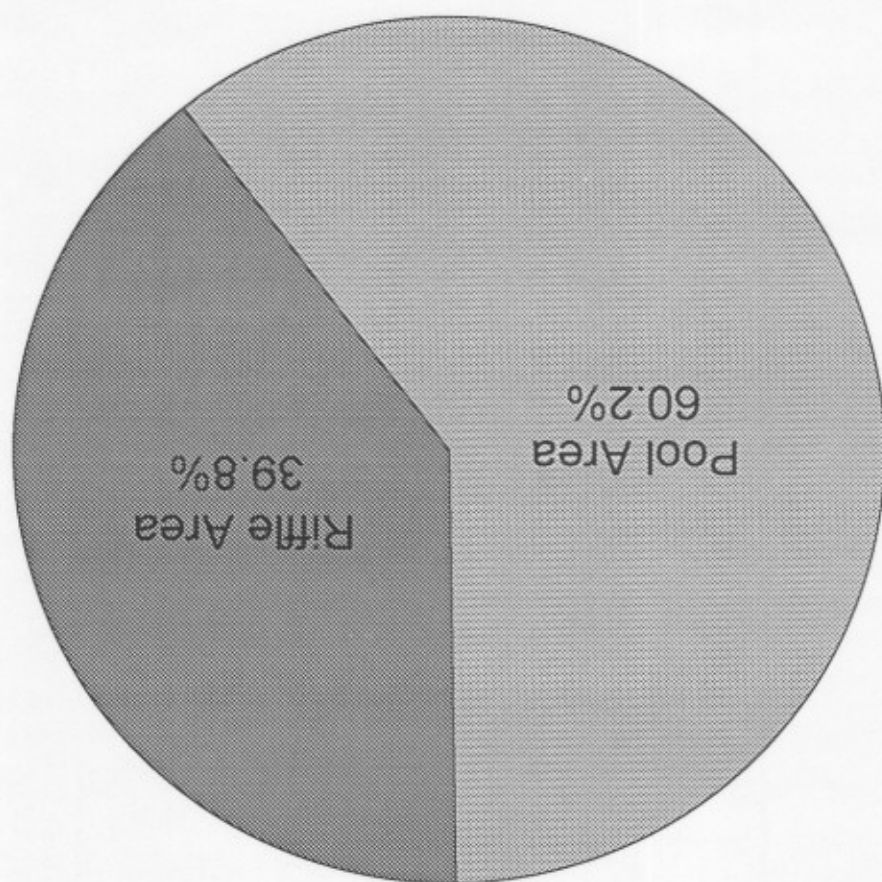


Figure 12. Distribution and position for the two larger size classes of large woody debris in the East Fork Overflow Creek section.

Figure 13. Pool:Riffle ratio for West Fork Overflow Creek.



Riparian Width

Stream: West Fork Overflow Creek

Number of measurements: 3

Mean width: 19.8 Std Dev: 5.8

Max: 31.3 Min: 13.5

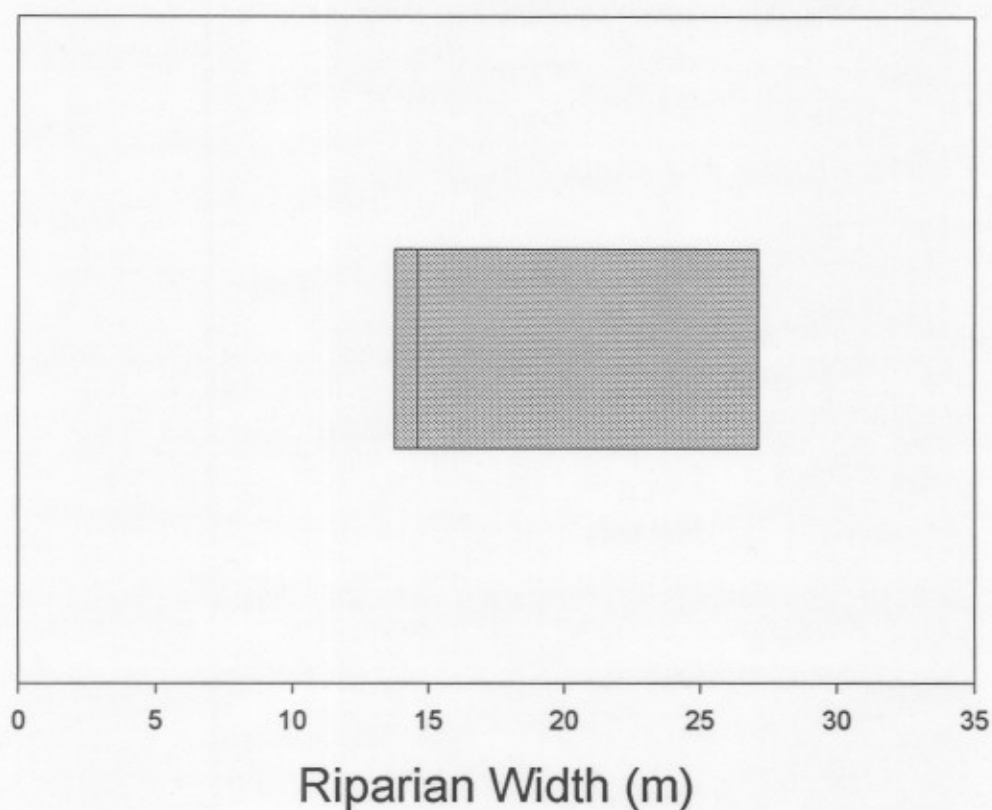


Figure 14. Box plots for riparian width in habitat-units of the West Fork Overflow Creek section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

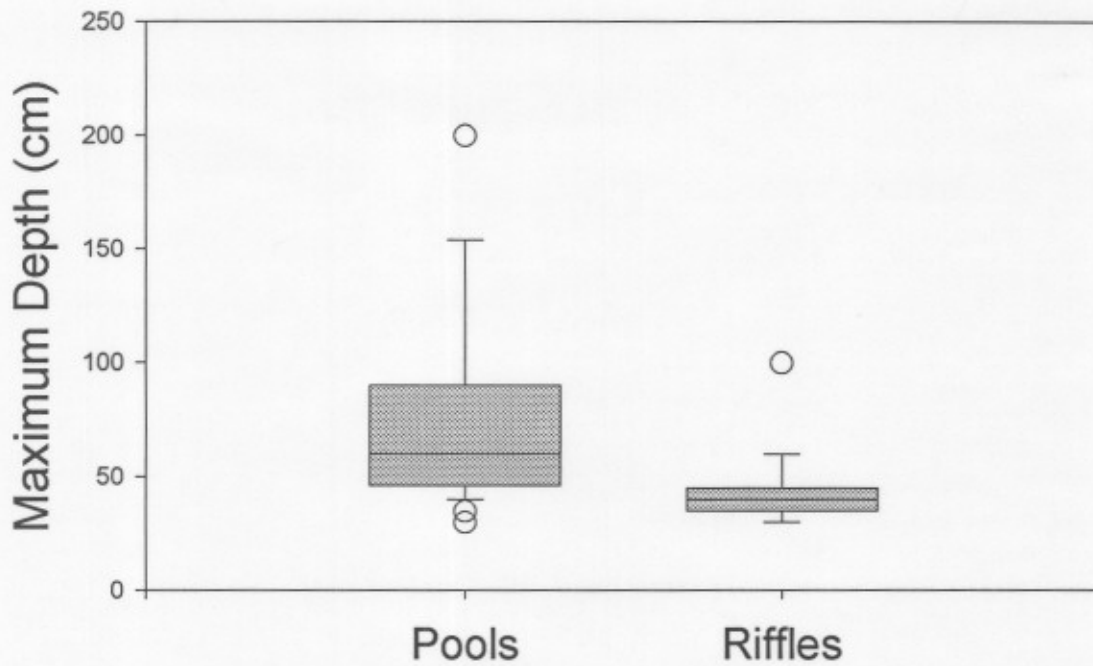


Figure 15. Box plots for habitat-unit maximum depth in the West Fork Overflow Creek section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

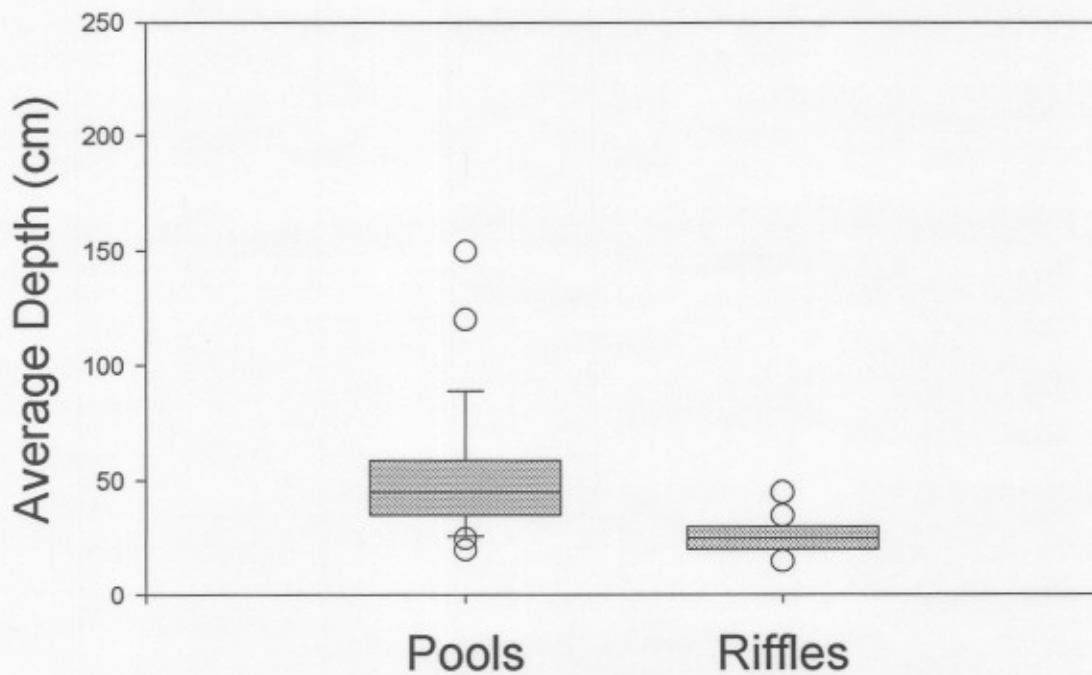


Figure 16. Box plots for habitat-unit average depth in the West Fork Overflow Creek section. The box encloses the middle 50% of the observations, the capped lines below and above the box represent the 10% and 90% quantiles, respectively, dots represent outliers and the solid line in the box represents the median.

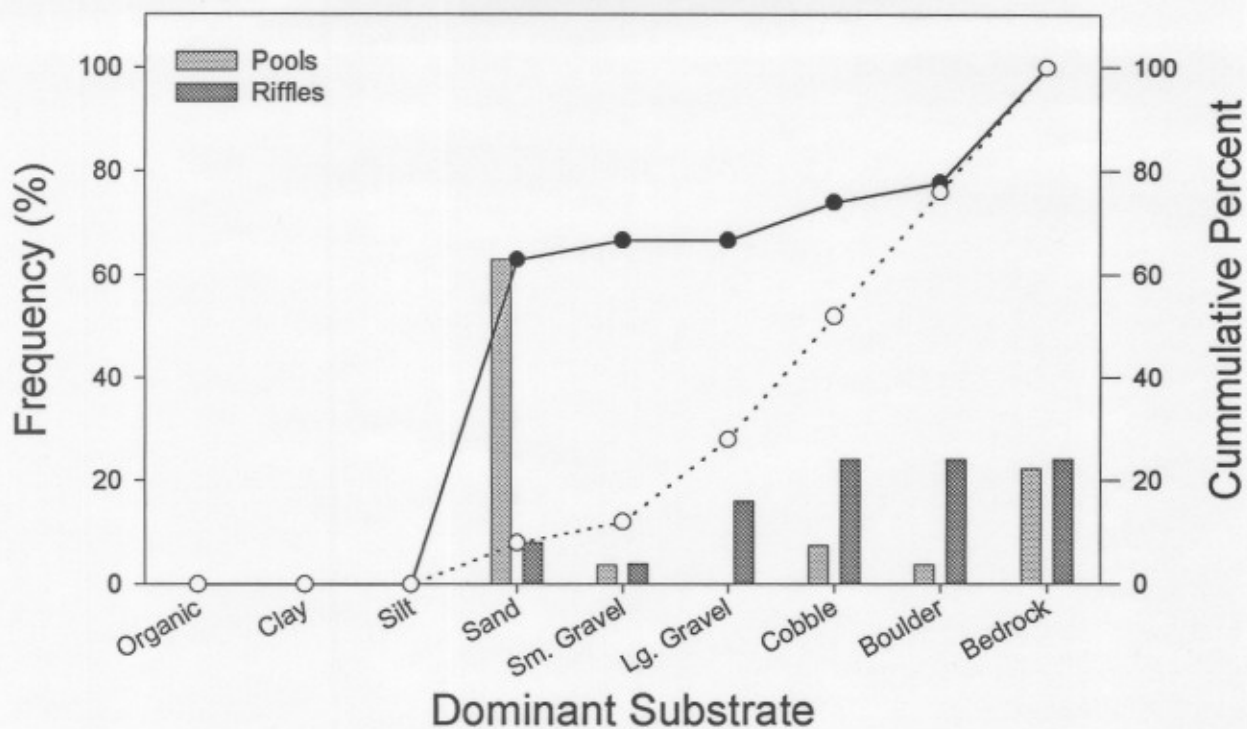


Figure17. Frequency (percent) of dominant substrate occurrence by habitat type in West Fork Overflow Creek. Solid dots represent cumulative percent of pools and open dots represent cumulative percent of riffles.

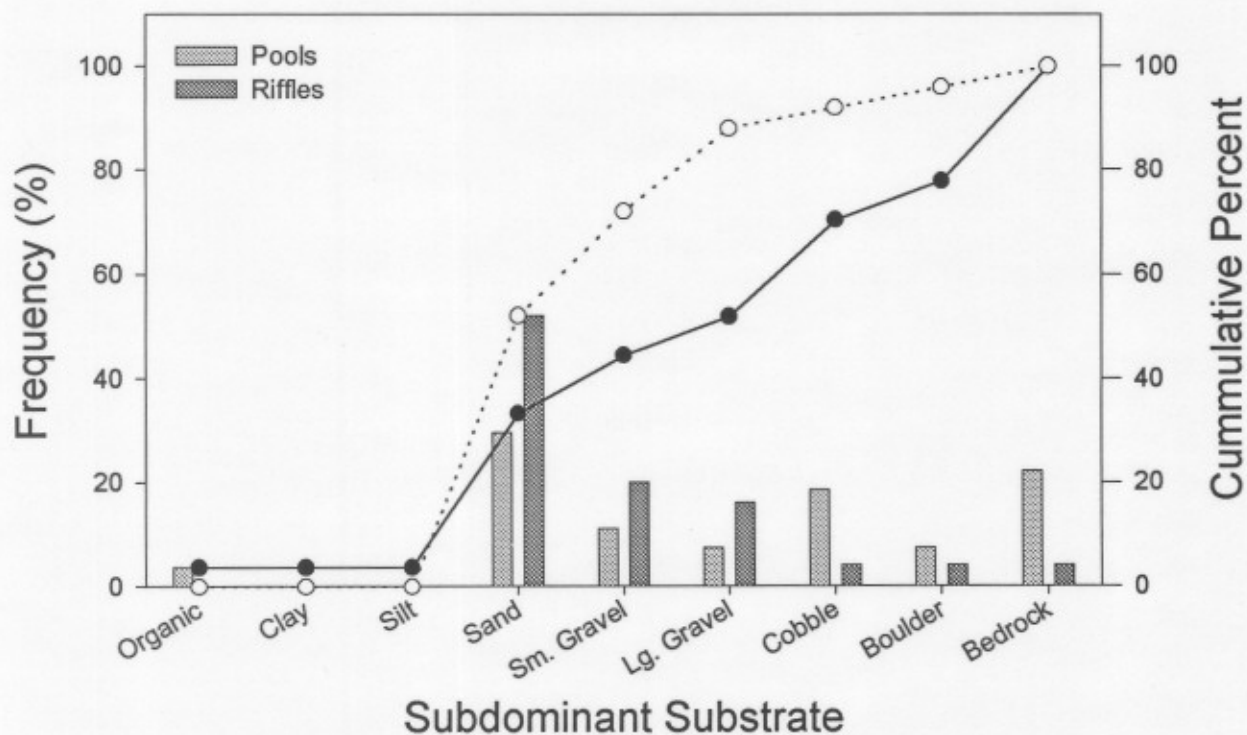


Figure18. Frequency (percent) of subdominant substrate occurrence by habitat type in West Fork Overflow Creek. Solid dots represent cumulative percent of pools and open dots represent cumulative percent of riffles.

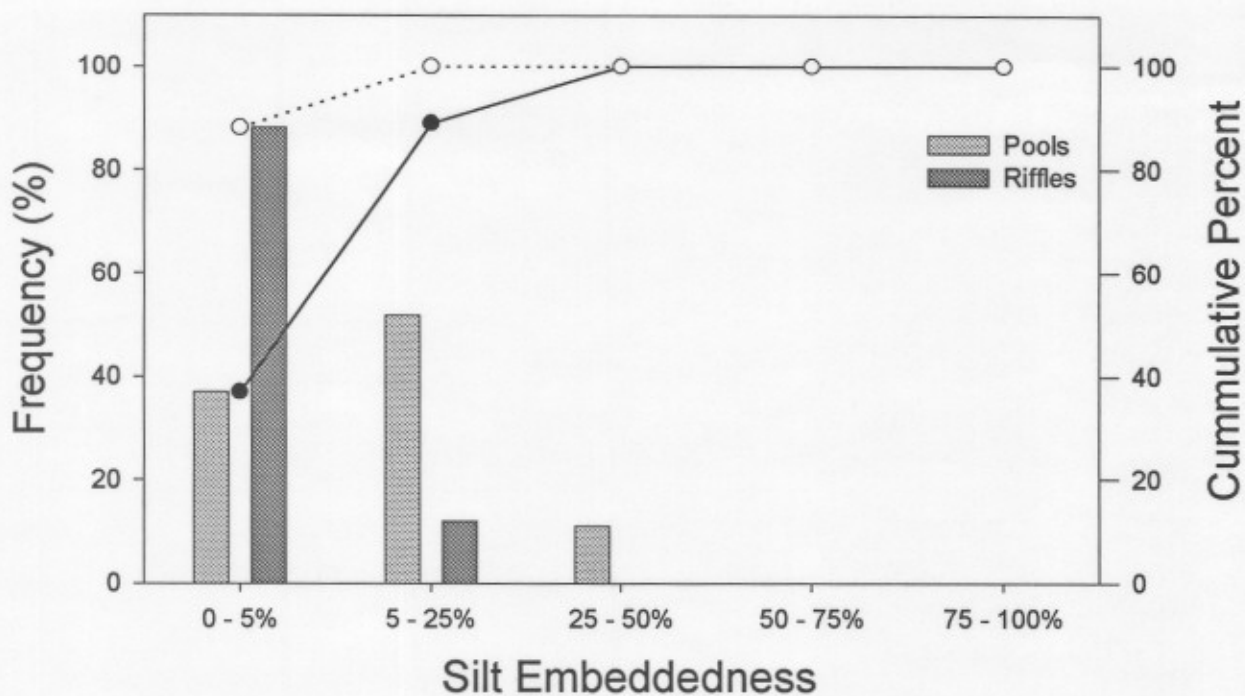


Figure 19. Frequency (percent) of pools and riffles in West Fork Overflow Creek best described by one of five classes of embeddedness. Solid dots represent cumulative percent of pools and open dots represent cumulative percent of riffles.

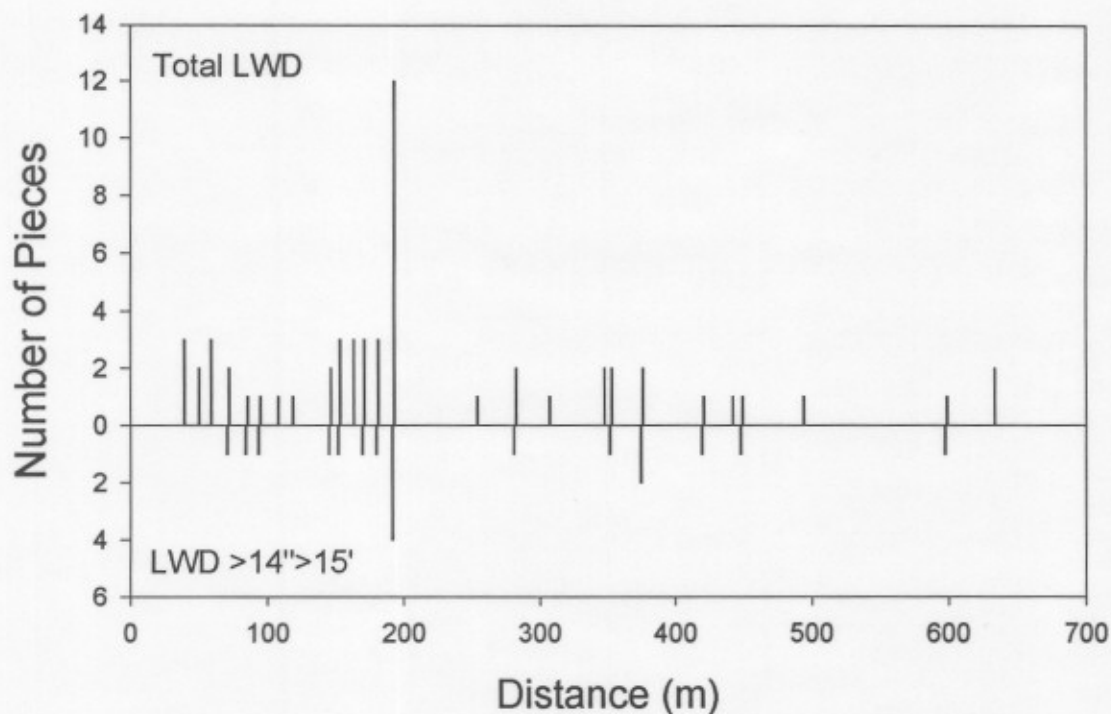


Figure 20. Distribution and total abundance of large woody debris in West Fork Overflow Creek.

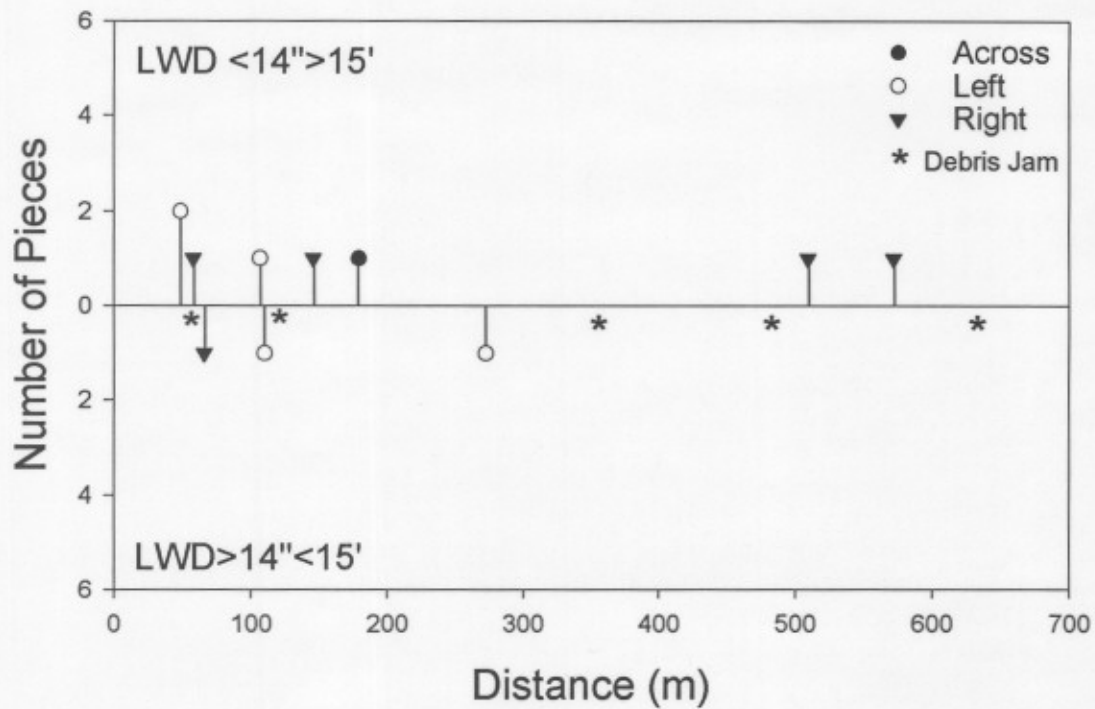


Figure 21. Distribution and position for the two smaller size classes of large woody debris in the West Fork Overflow Creek section. Asterisks denote debris jams.

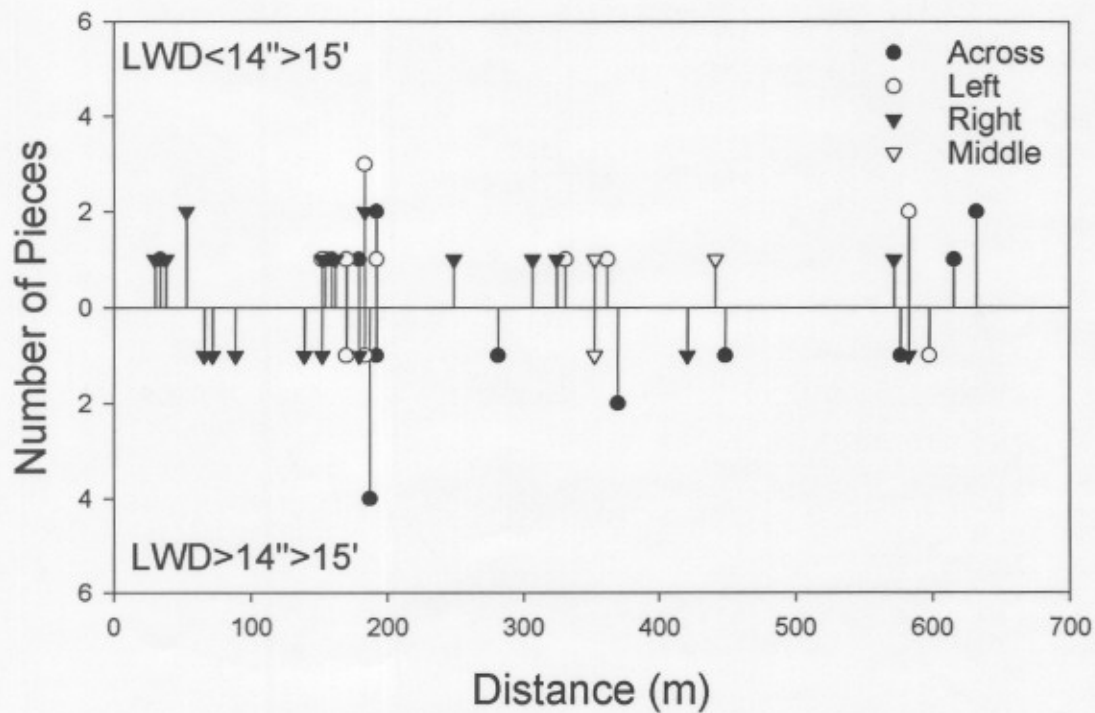


Figure 22. Distribution and position for the two larger size classes of large woody debris in the West Fork Overflow Creek section.